AIR MOVEMENT RESTRAINTS

UMODD03
TBOLC 500-500-14

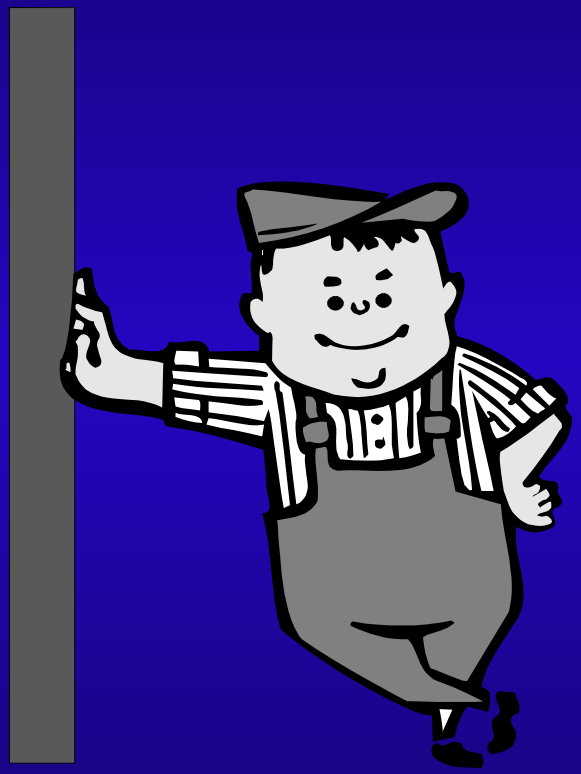
AIRCRAFT SHORING FUNDAMENTALS

LOAD AND SECURE CARGO FOR AIR MOVEMENT

REFERENCE

DOD 4500.9-R DEFENSE TRANSPORTATION REGULATION PART III MOBILITY

Shoring



Shoring

- Lumber or planking material
- Protects aircraft cargo floor and ramps from damage
- Increases cargo contact areas for better load distribution
- Decreases the approach angle of the aircraft cargo ramps
- Provided by transported unit
- **Minimum thickness for all shoring = 3/4 inch.** Actual dimensions driven by weight, contact area and aircraft limitations
- Aircraft load master will supervise the placement of shoring on the cargo floor to maximize its effectiveness

Types of Shoring

- Rolling
- Parking
- Sleeper
- Special

Rolling Shoring

- Used on ramps and cargo floor areas over which a vehicle must roll when being loaded/unloaded from an aircraft
- Protects aircraft floors and ramps from damage
- Used primarily with tracked vehicles (any vehicle with tracks, cleats, studs or other gripping devices or treads where there will be metal-to-metal contact requires rolling shoring). Generally not required for wheeled vehicles as they do not exceed weight limitations (Tracked vehicles could deploy with new rubber pads but redeploy with worn pads & need shoring)
- Any equipment requiring rolling shoring requires parking shoring

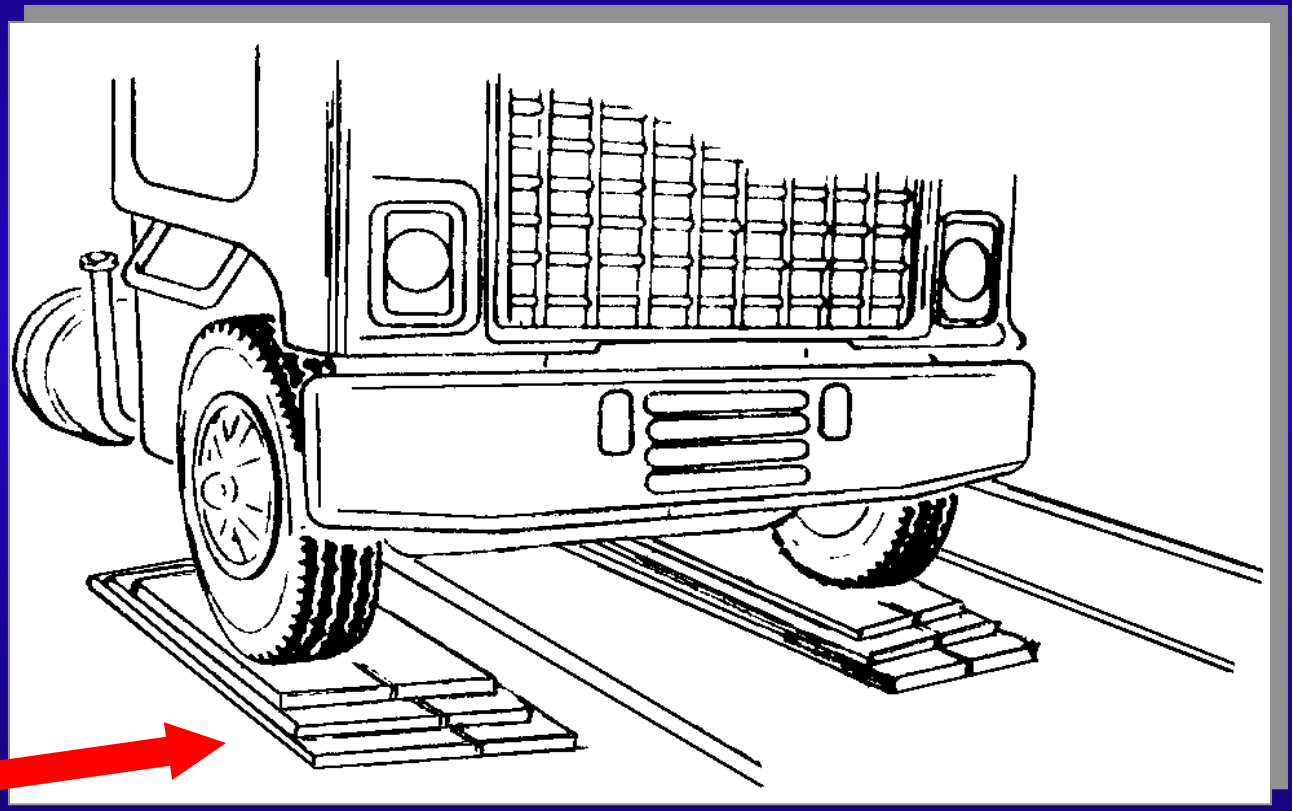
Rolling Shoring (cont)

Rolling shoring used on aircraft ramp

Used to protect the floor from vehicles with cleats, studs or other gripping devices

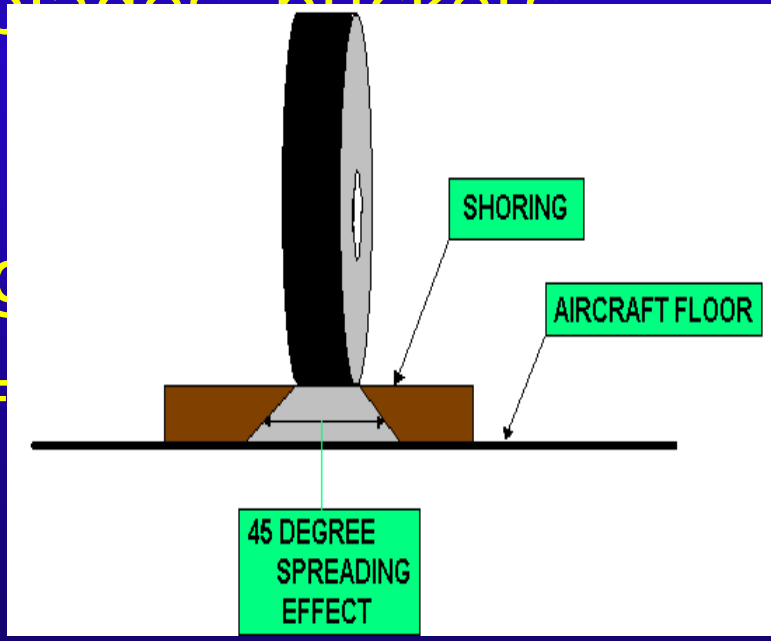
Parking Shoring

- Generally, if you need rolling shoring you will need parking shoring



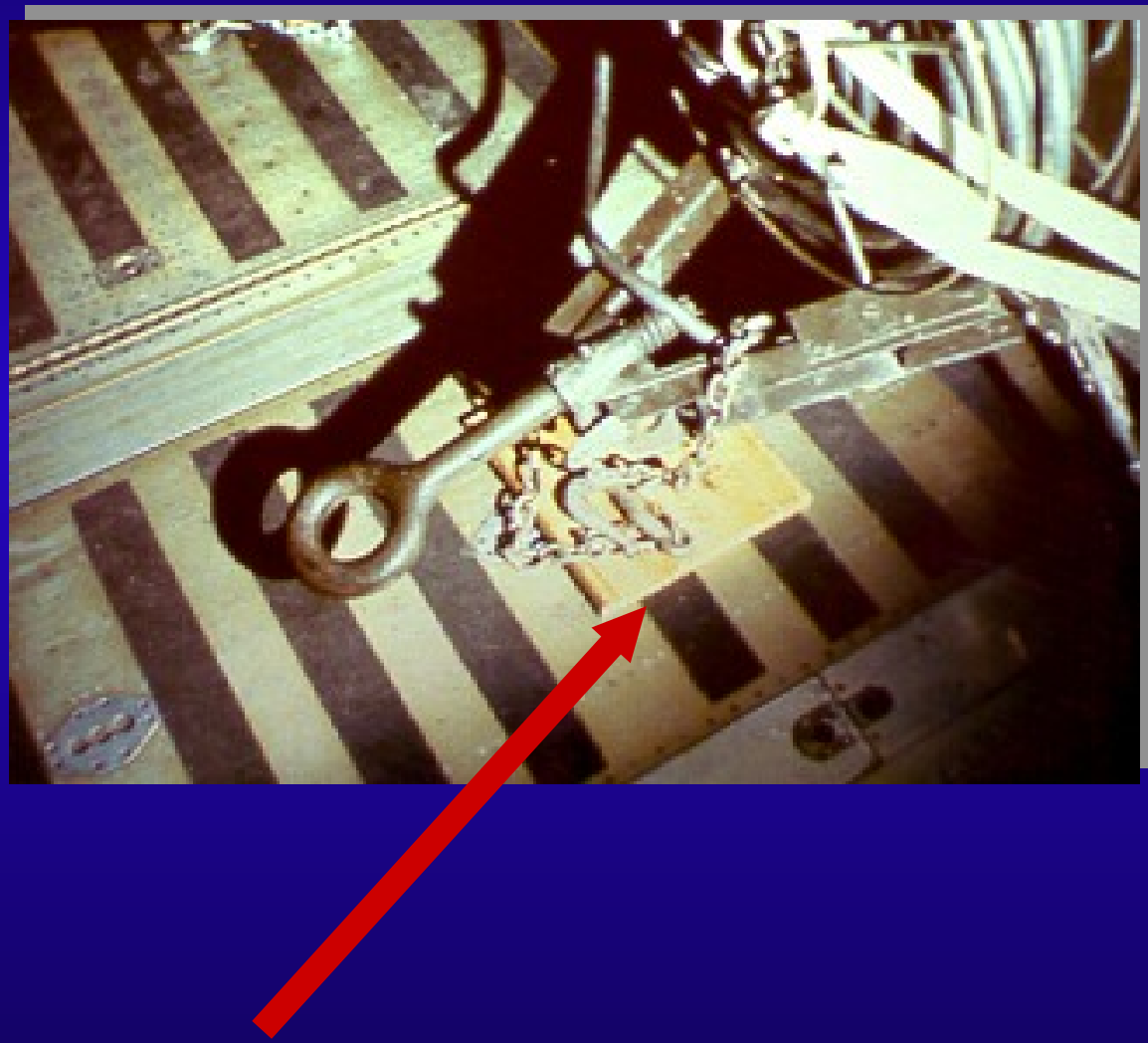
Parking Shoring (cont)

- Used under items when loaded and parked aboard the aircraft
- Protects aircraft floor from damage during flight
- Prevents metal-to-metal contact of cargo with aircraft cargo compartment floor (consider blades, buckets, fork-lift tines etc)
- Distributes cargo weight over a larg
contact area of cargo compartment f



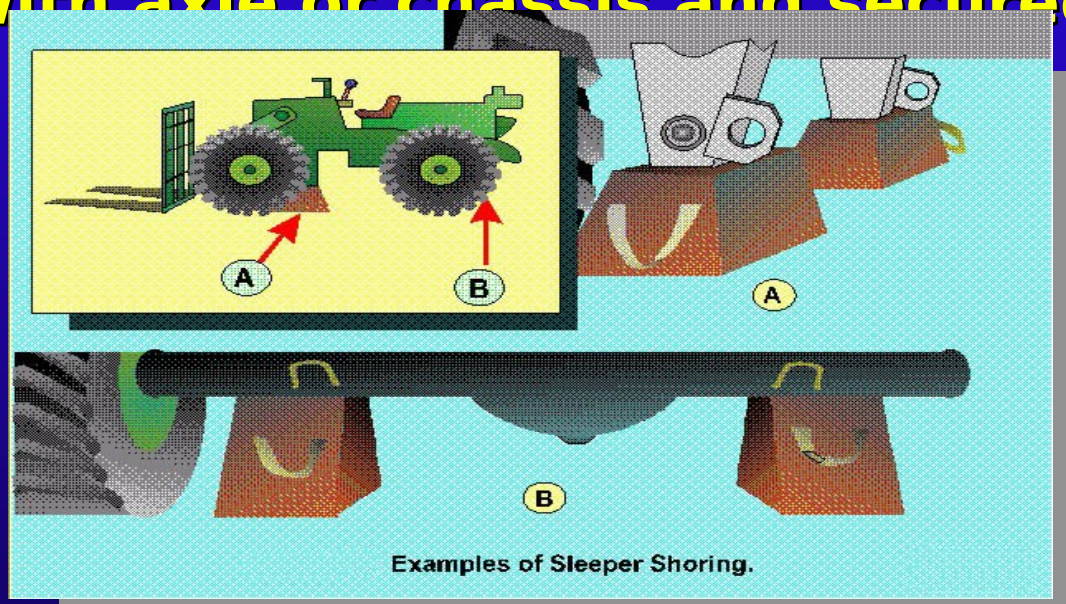
Parking Shoring (cont)

- All trailers with a tongue that could rest on the aircraft floor should be shipped with parking shoring, whether connected to or disconnected from its prime mover



Sleeper Shoring

- **Use under frames or axles of vehicles that weigh over 20,000 pounds with soft, low pressure, balloon-type, off road tires that are not designed for highway travel (eg forklifts, road graders etc)**
- **Sleeper shoring used to prevent the vehicle from bouncing up and down and possibly pulling the tie down rings out of aircraft floor**
- **Placed flush as practical with axle or chassis and secured to prevent movement**



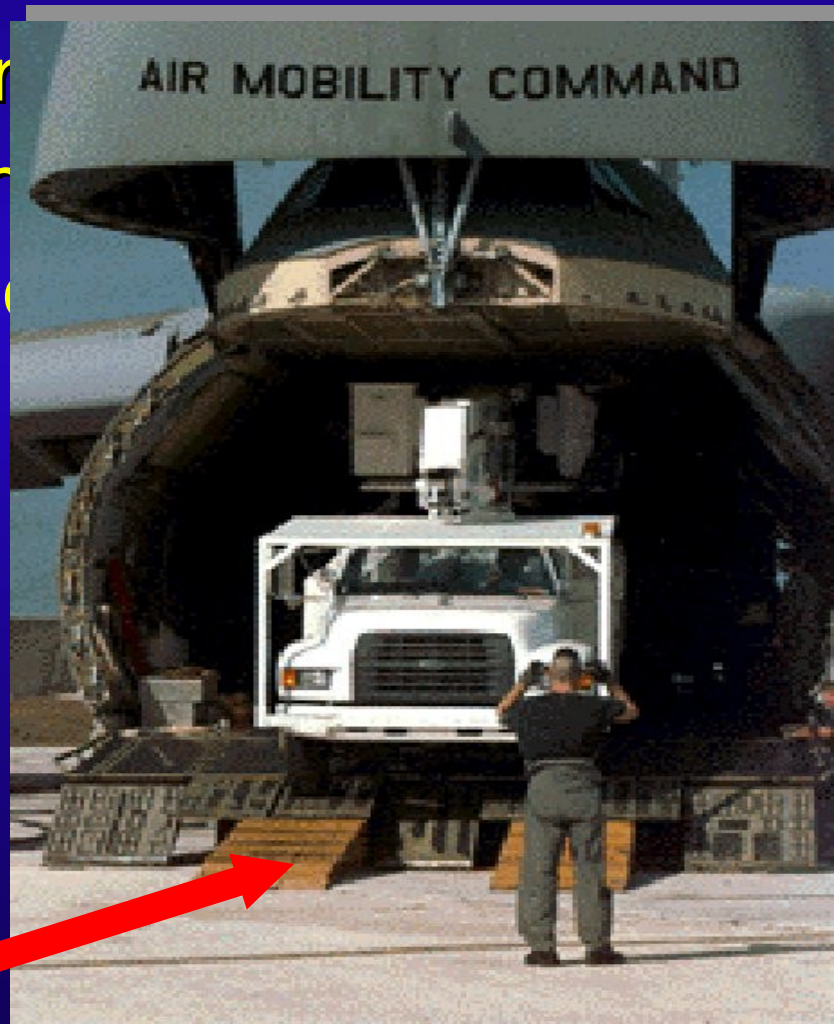
Examples of Sleeper Shoring.

Special Shoring

- All other types of shoring
  - Approach shoring
  - Ramp pedestal shoring

Special Shoring - Approach Shoring

- Use approach shoring to decrease the approach angle of aircraft loading ramps
- Prevents tall and long items of car
  from striking the aircraft or groun
  during loading/offloading operati

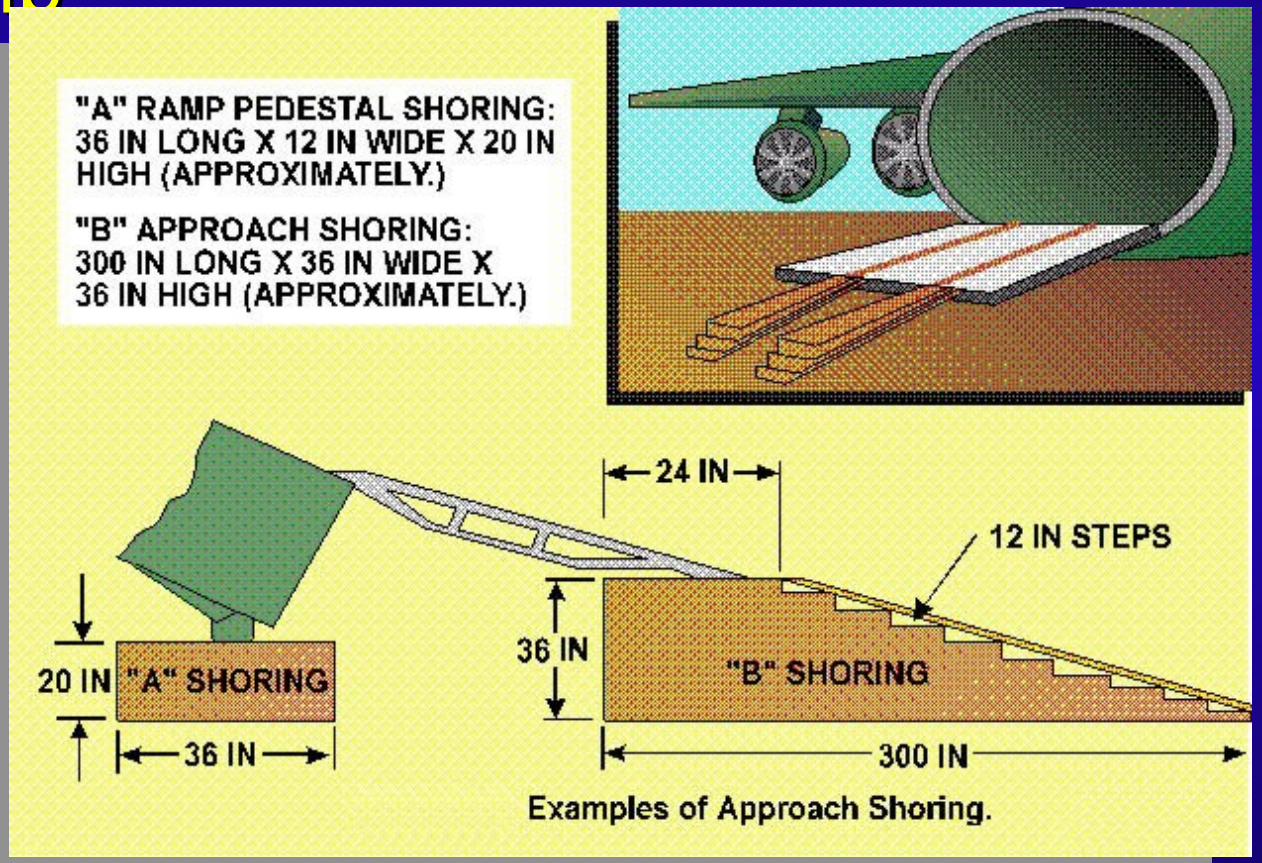


Special Shoring - Approach Shoring (cont)

- Decreases angle or slope of the aircraft cargo ramp
- Reduces upward projection of cargo to provide overhead and/or ground clearance
- No standard method
- Used when ground clearance is limited
- Examples:
  - Most helicopters
  - All 40K loaders
  - Long vehicles

Special Shoring - Ramp Pedestal Shoring

- Decreases angle of the aircraft cargo ramp
- Consists of lumber placed under the aft end of the cargo ramp



Examples of Approach Shoring.

FUNDAMENTALS OF RESTRAINT

- RESTRAINT CONSIDERATIONS
  - GRAVITY FORCE **“G”s**
  - GROSS WEIGHT OF CARGO (ITEM)
  - RATE OF CHANGE” **“SPEED”**

RESTRAINT CRITERIA

- **FORWARD 3.0 G's**
- **AFT 1.5 G's**
- **LATERAL (L/R) 1.5 G's**
- **VERTICAL 2.0 G's**

C-130, C-5, C-17

KC-10 AIRCRAFT NOTE

Forward restraint for KC-10 is 9.0 G's without a barrier net.

Standard is 1.5 G's with barrier net installed.
All other directional restraint is the same as the other cargo aircraft.

RESTRAINT EQUIPMENT

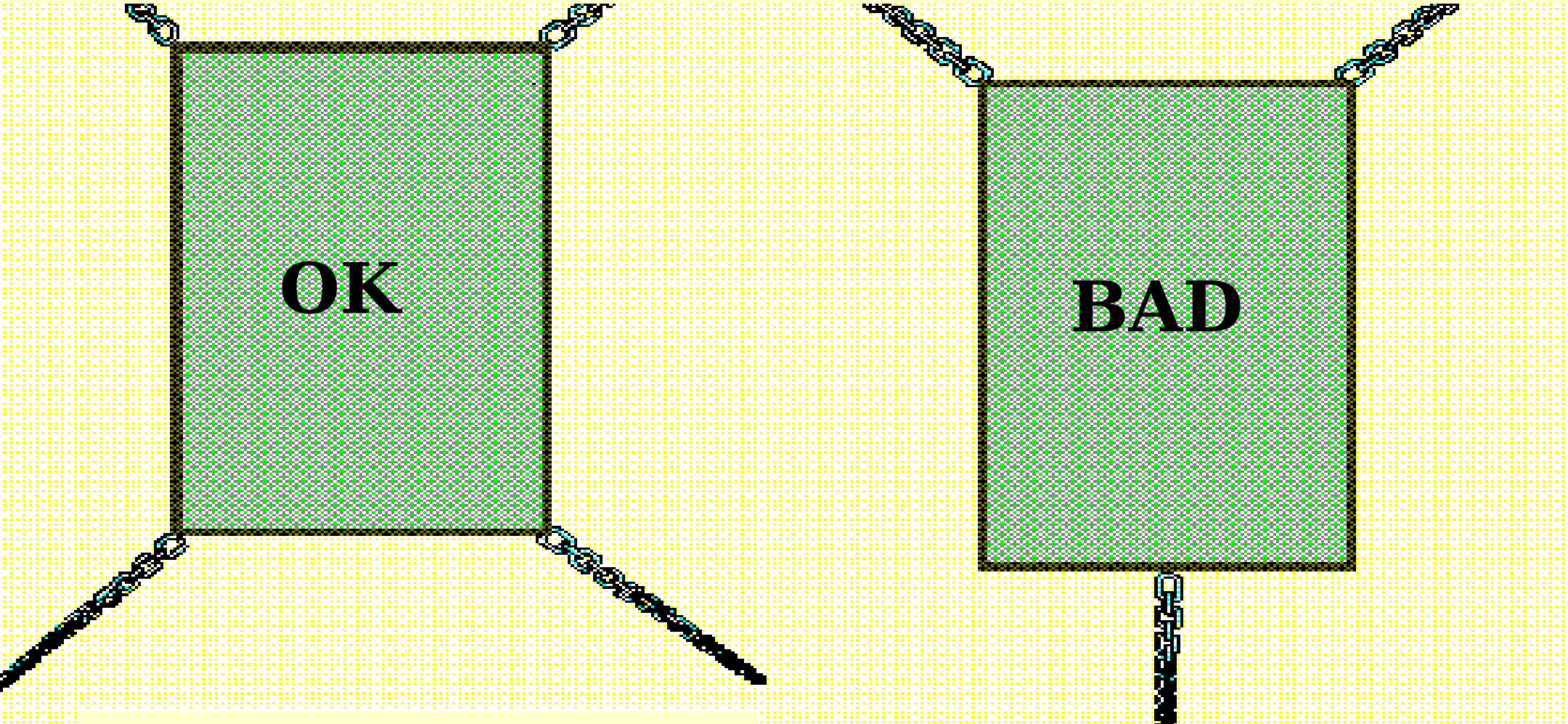
- **CHAINS & DEVICES**
  - MB-1 10,000 LB
  - MB-2 25,000 LB
- **STRAPS**
  - CGU-1/B 5,000 LB

RULES OF APPLICATION

- Attain required directional restraint
- Attach symmetrically and in pairs
- Attach to primary points
- No more than half to axles - one direction
- Don't cross brake lines or cables

TIE-DOWNS

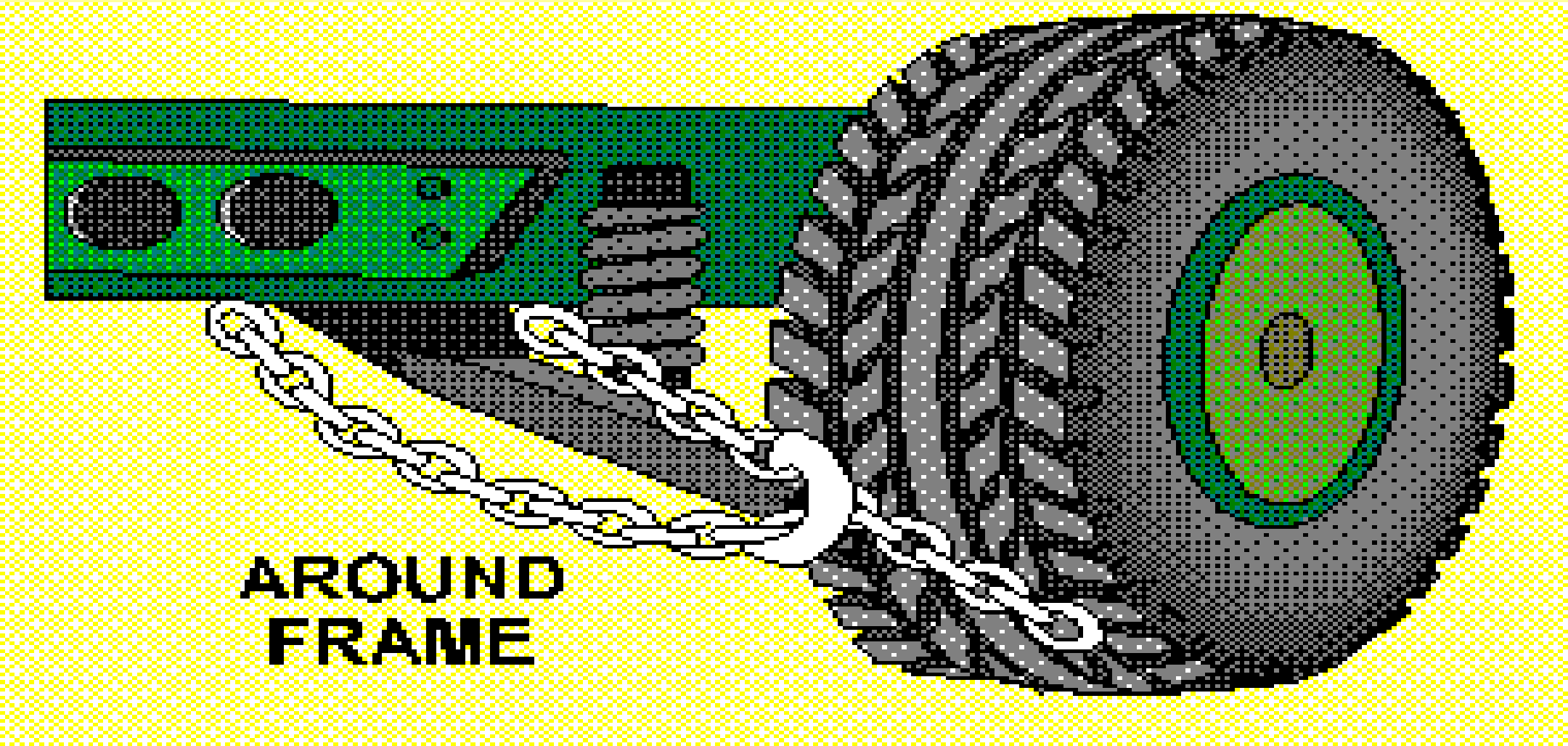
SYMMETRICAL NON-SYMMETRICAL



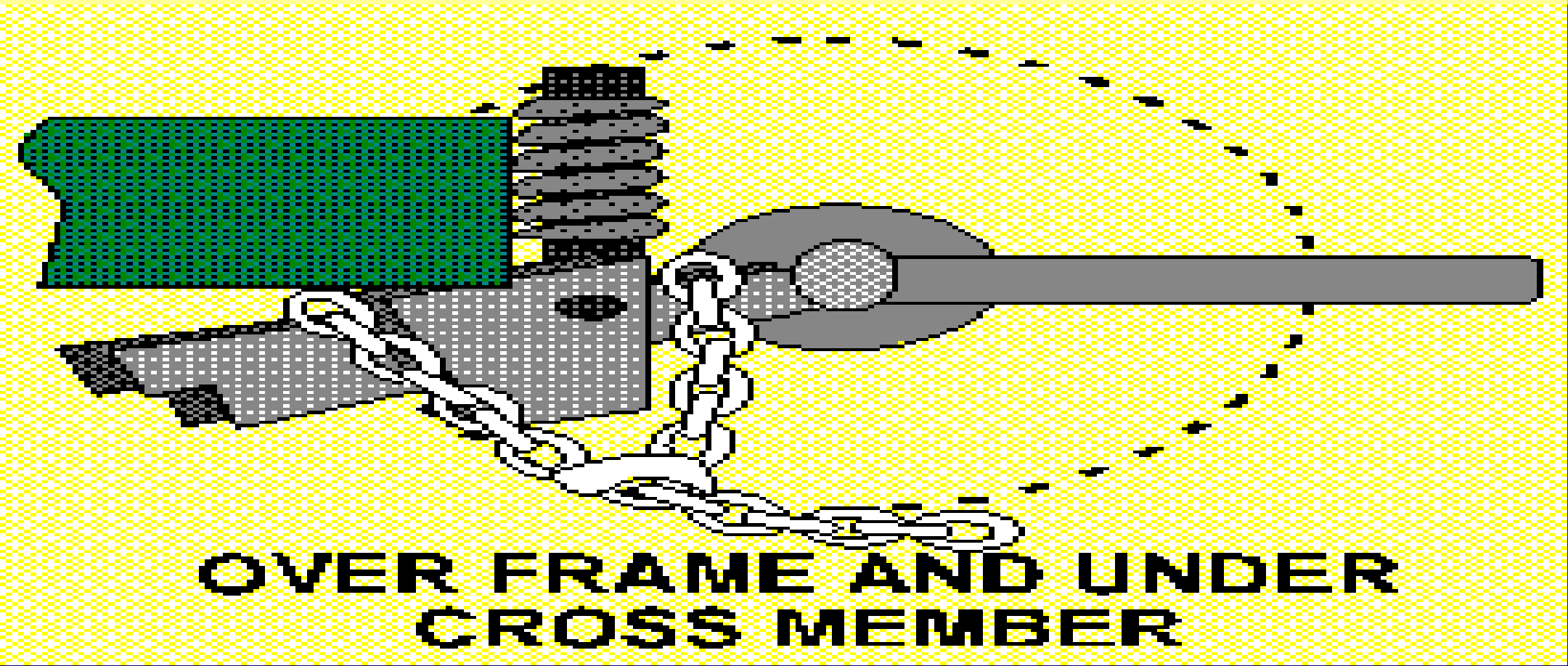
ATTACHMENT POINTS

- **Bumper (Use clevises if installed)**
- **Frame**
- **Axle**

Attach tie-down devices to designed tie-down points such as lifting shackles, if available. If they are not available use strong structural points such as frame members, bumper supports, or axles.

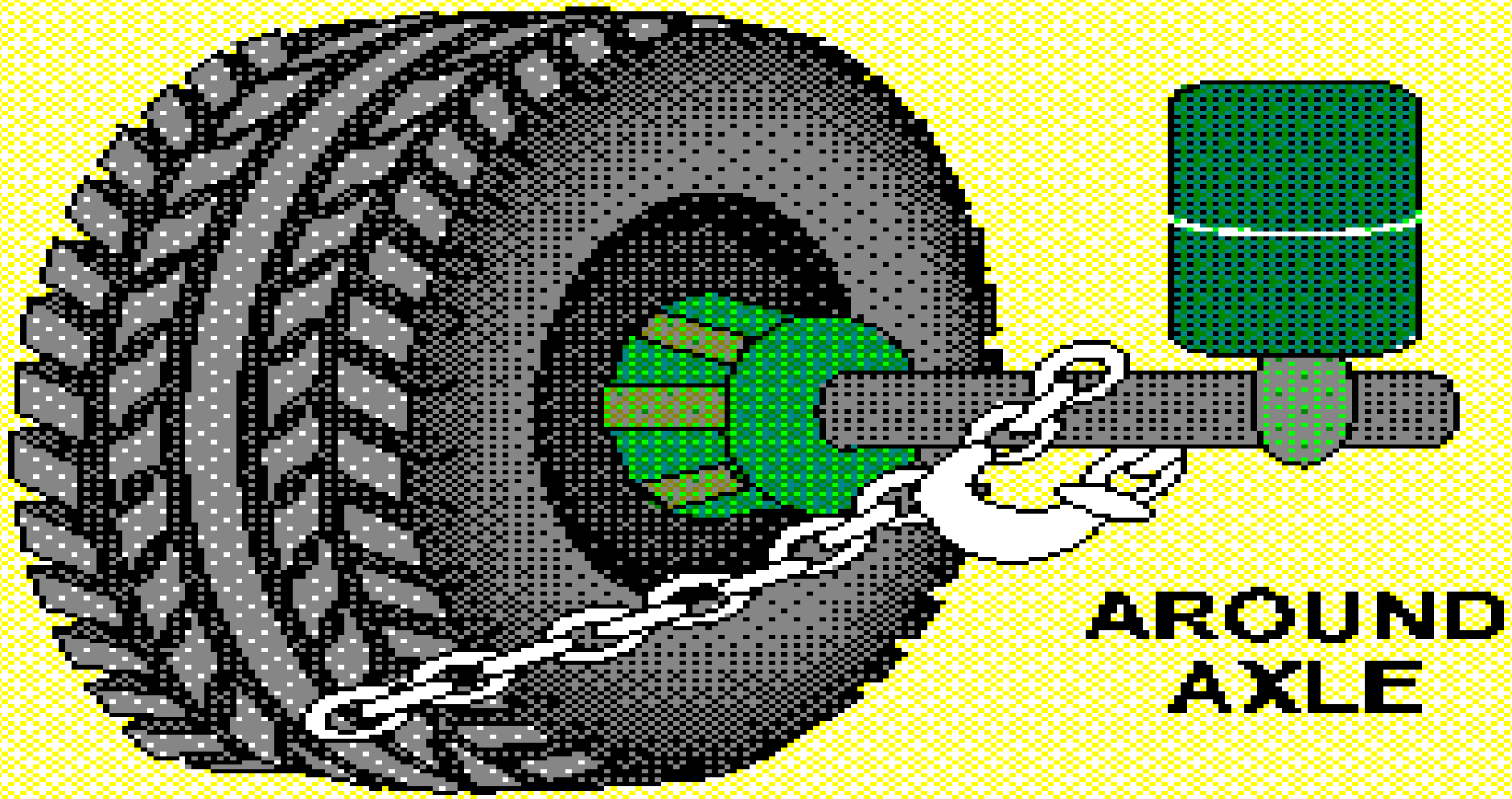


Over the frame and under the cross member is similar to restraining the axle which mainly restrains unsprung weight (axles, tires, etc.) as opposed to restraining the frame which is sprung weight (all weight above the springs and axles).

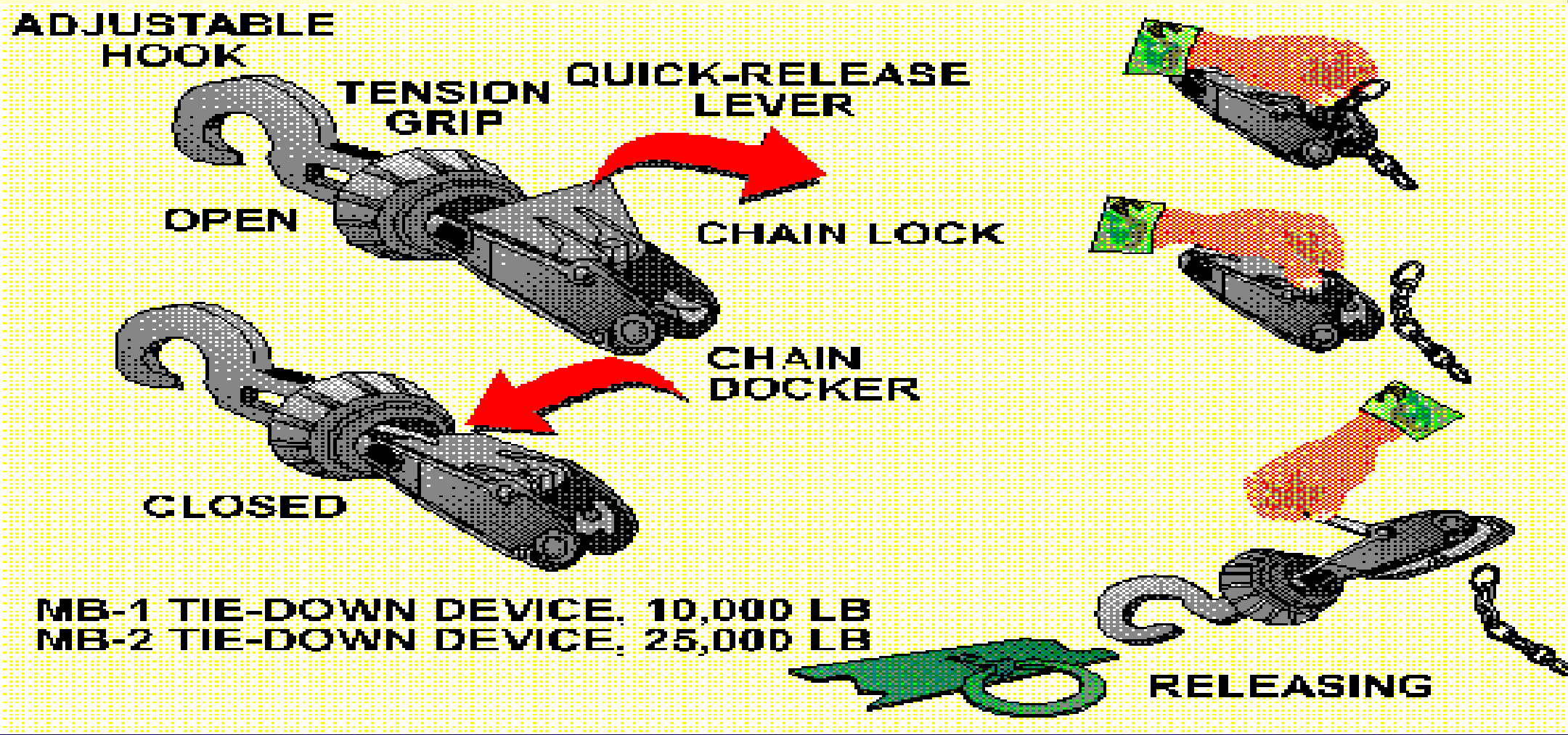


When using the axle as a tie-down point, do not depend on friction or tension to prevent the chain from sliding.

Place the chains against something solid such as brackets or housings. Use no more than 50% of restraint on axles in any given direction, and do not crush air, hydraulic, or fuel lines.



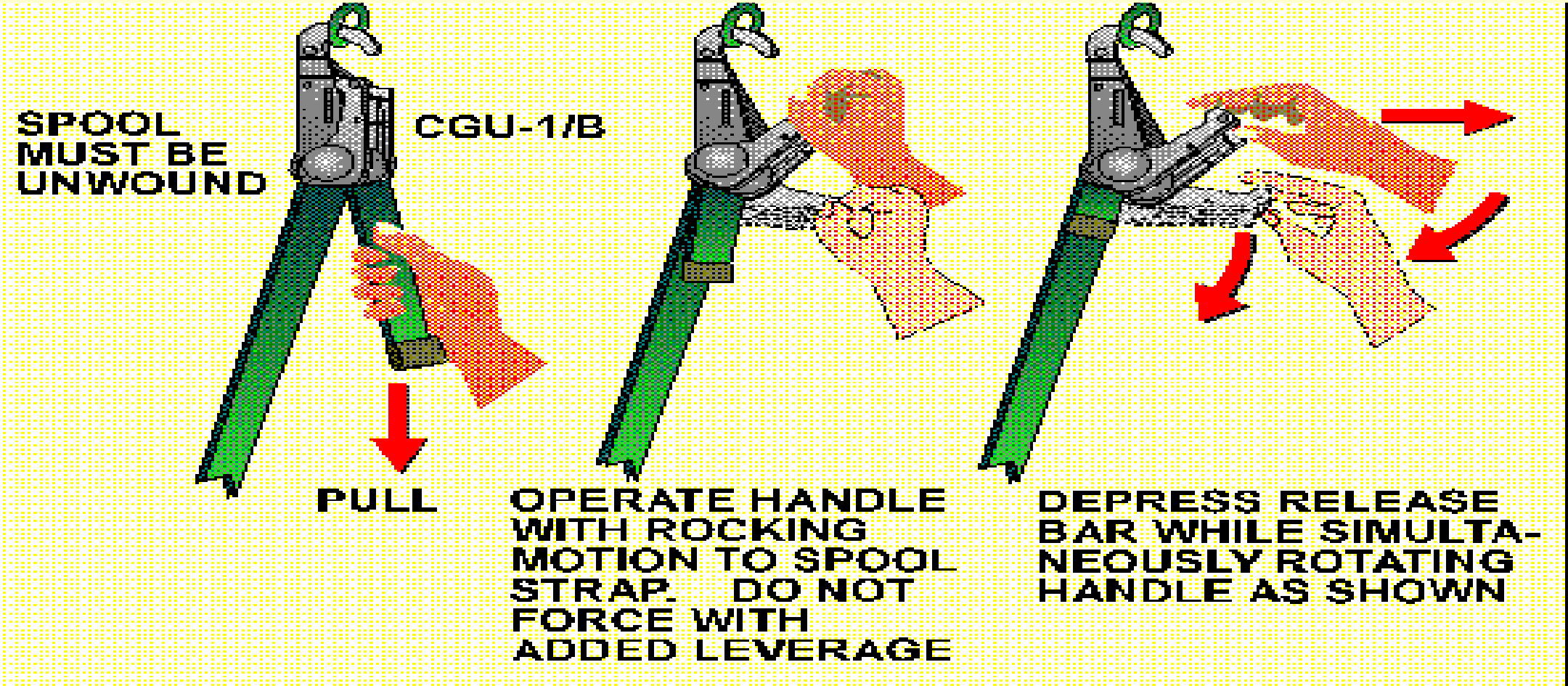
- **Turn the rings in the floor and tie-down fittings so that tension is applied to the top of the ring.**
- **Attach the hook end of tie-down to aircraft floor & chain's hook to cargo.**



CGU-1/B CARGO STRAP

Use protective padding when using the CGU-1/B strap to secure cargo with edges.

Use cargo straps on cargo that may be damaged by chains.



PREFERRED ANGLES OF APPLICATION

- **30 DEGREE PLAN & 30 DEGREE FLOOR ANGLE**

  (30 X 30)

- **45 DEGREE PLAN & 45 DEGREE FLOOR ANGLE**

  (45 X 45)

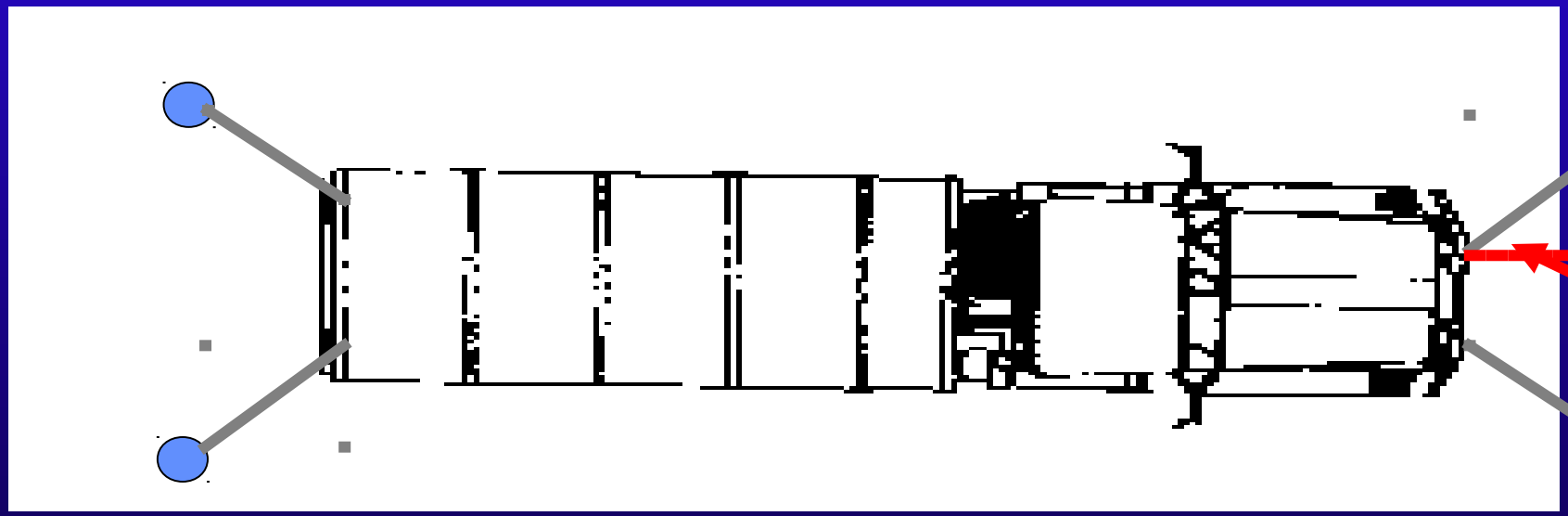
TIE-DOWN PATTERN

Whenever possible, install tie down devices at an angle of 30° from the cargo floor and 30° from the longitudinal axis.

Lead the tie-down directly from floor fitting to the load being controlled.

Tie-down devices and fittings must be equal strength.

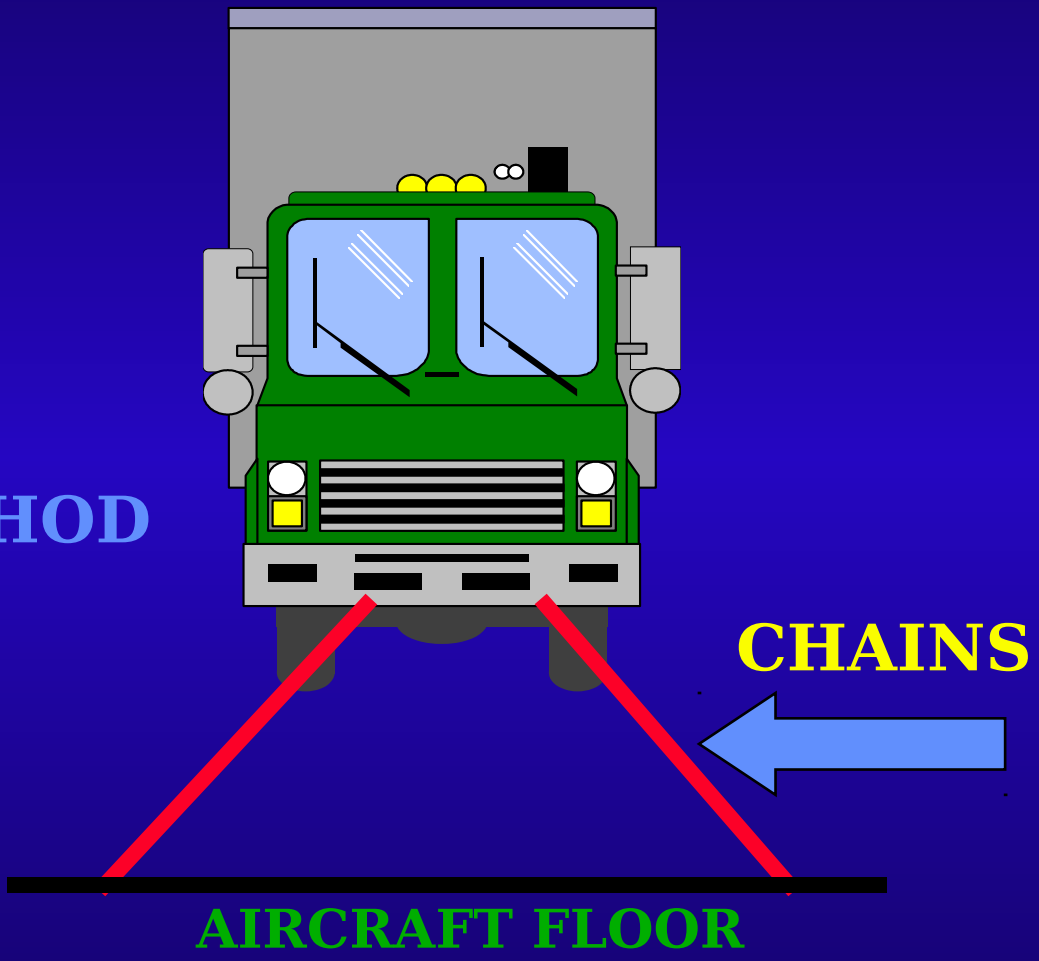
Tighten devices so that equal tension is maintained throughout the arrangement.



METHODS OF APPLICATION

OPEN

PREFERRED METHOD

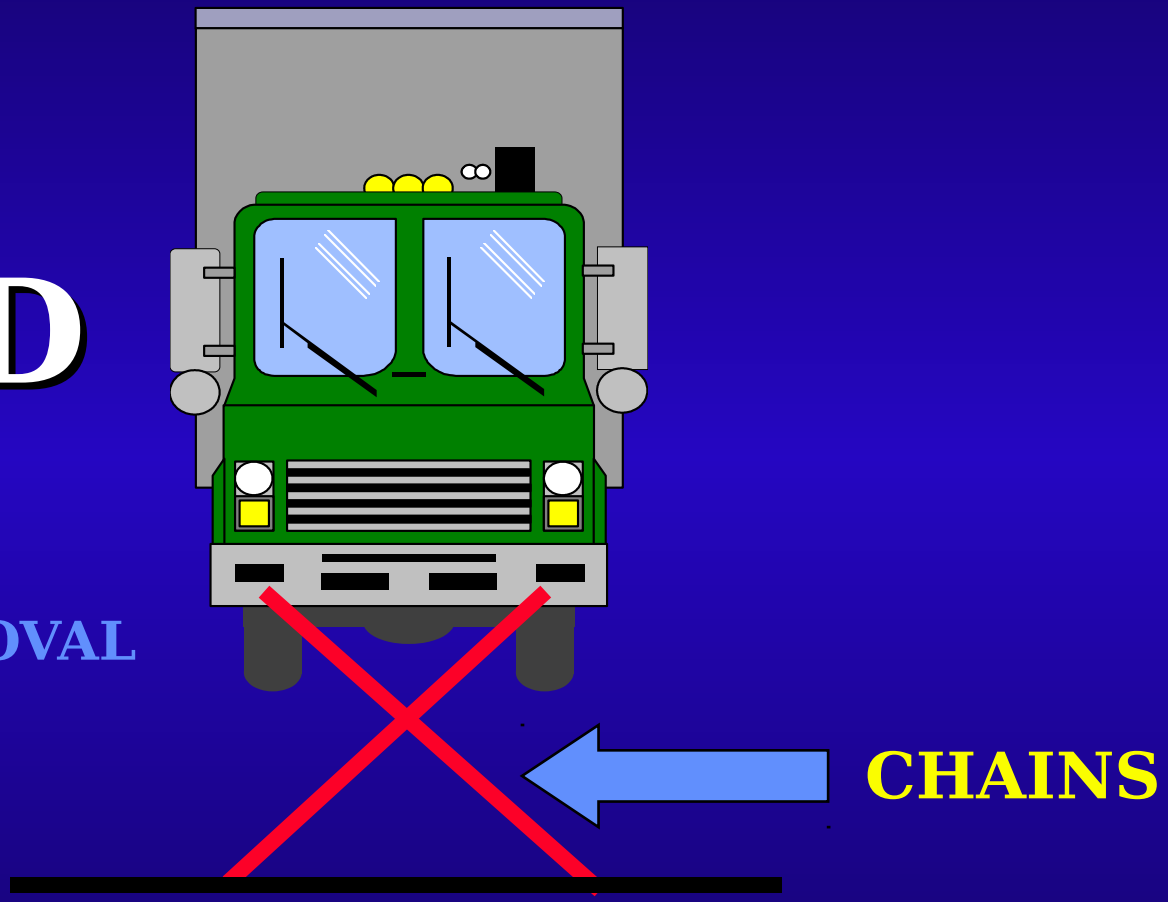


METHODS OF APPLICATION

CLOSED

(CROSSED)

WITH AIRCRAFT
LOADMASTER APPROVAL



PERCENT EFFECTIVENESS

- 30º x 30º = 75 %
- 45º x 45º = 50 %

APPROXIMATE RESTRAINT OBTAINED

- 30º x 30º 10,000 lbs. x 75% = 7,500 lbs.
  MB-1
- 45º x 45º 10,000 lbs. x 50% = 5,000 lbs.
  MB-1

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- 30º x 30º 25,000 lbs. x 75% = 18,750 lbs.

  MB-2
- 45º x 45º 25,000 lbs. x 50% = 12,500 lbs.
  MB-2

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- CGU-1/B 5,000 lbs. x 75% = 3,750 lbs.

RESTRAINT FORMULA

RESTRAINT CRITERIA (G) x WEIGHT OF ITEM = # OF TIEDOWNS
APPROXIMATE RESTRAINT OBTAINED REQUIRED

Take the directional restraint in Gs and multiply it by the gross weight of the item of cargo to be restrained. Then divide this number by the approximate amount of restraint coming from the tie-down chains/devices based on the angle applied (30x30 angle or 45x45 angle). The result is the number of chains needed (in even numbers) to secure the cargo for that given direction.

SAMPLE APPLICATION OF FORMULA

(USING MB-1 CHAINS/DEVICES)

$$\frac{\text{3.0 G's FWD x 10,000 lb. item}}{\text{7,500 LBS}} = \text{?}$$

 # chains required

SAMPLE SOLUTION FOR FORMULA

$$\frac{30{,}000}{7{,}500} = 4$$

- **REQUIRES 4 CHAINS**

SAMPLE PROBLEM

SITUATION:

A 20,000 LB. VEHICLE IS TO BE RESTRAINED USING MB-2 CHAINS AND DEVICES AT A 30º x 30º ANGLE.

HOW MANY CHAINS ARE REQUIRED ?

SAMPLE PROBLEM

RESTRAINT CRITERIA	X	WEIGHT OF ITEM	=	REQUIRED RESTRAINT	÷	APPROXIMATE RESTRAINT OBTAINED	=	# OF TIEDOWNS REQUIRED
FWD 3.0	X		=		÷		=	
AFT 1.5	X		=		÷		=	
LAT 1.5	X		=		÷		=	
VERT 2.0	X		=		÷		=	

- IN GENERAL, PROPER APPLICATION OF FORWARD AND AFT RESTRAINT WILL SATISFY LATERAL AND VERTICAL RESTRAINT.

CONSULT WITH AIRCRAFT LOADMASTER FOR ANY ADDITIONAL RESTRAINT REQUIREMENTS.

SUMMARY

SHORING

CRITERIA

EQUIPMENT

APPLICATION

EFFECTIVENESS

FORMULA